# CHAPTER 1. INTRODUCTION

## 1-1.01 Purpose and Scope

The *California Falsework Manual* has been issued by the Department of Transportation's Division of Structures to-fill a long-recognized need for a comprehensive design and construction manual devoted exclusively to bridge falsework. Its intended purpose is to provide administrative and technical direction to the Division's field engineers who are in responsible charge of bridge construction on State highway projects. While emphasis is placed on contract administration, it is important to note that materials, design considerations, stress analysis, review criteria, construction and construction inspection are covered as well.

Proper use of the *California Falsework Manual* requires a thorough understanding of the principles of civil engineering design, and familiarity with the falsework specifications as well.

## 1-1.02 Statement of Department Policy

The *California Falsework Manual* sets forth Department of Transportation policy for administration of specifications governing the design and construction of falsework for structures on State highway projects. The manual also includes guidelines, instructions and procedures which are to be followed on all projects to ensure uniform and impartial contract administration. Project personnel who are responsible for review and approval of falsework drawings and/or inspection of falsework construction are expected to become thoroughly familiar -with the contents of this manual.

When referring to the *California Falsework Manual,* field personnel should keep in mind that it is not, and it is not intended to be, a contract document. Should there be any conflict between the manual and any contract provision, the contract provision must be followed. This is not to say, however, that the manual has no contractual significance. On the contrary, Section 4-1.01 of the Standard Specifications provides that in the absence of specific direction or complete detail, "... only the best general practice is to prevail...". Contractually, then, with respect to design and construction of bridge falsework, the *California Falsework Manual* represents the Department's opinion as to what constitutes "best general practice" within the meaning of this term as it is used in the Standard Specifications.

Analytical procedure and review criteria used by the Division of Structures to evaluate the adequacy of falsework designs, as set forth in this manual, are based on more than two decades of

continuing study by the Division's engineering staff of the behavior of individual components of the falsework system, and of the behavior of the system as a whole, as the design loads are applied. These studies, which covered a wide range of typical load combinations, led to the development of simplified methods which may be used to evaluate the adequacy of complex falsework configurations. Where appropriate, the Division has adopted a simplified approach to standardize and facilitate the review process.

For elements of the falsework system that are mathematically indeterminate, the Division's simplified methods and procedures provide reasonably close correlation when compared to results obtained by conventional, rigorous analysis; consequently, they will be applicable to the type of falsework encountered on typical bridge projects in California. Occasionally, however, a situation will arise where analysis using a simplified approach may be inappropriate. In such situations, the design review should include a rigorous analysis to ensure stability of the falsework system. (A falsework system composed of custom-built, multi-tiered structural steel frames or towers is an example of a design where a rigorous analysis would be warranted.) The bridge engineer responsible for review of the falsework design will be expected to recognize such situations and to consult with the Office of Structure Construction headquarters office for the procedure to be followed.

If the contractor's design of an indeterminate element of the falsework system is based on a rigorous analysis as shown by the design calculations, and if the contractor so requests in writing, system adequacy will be evaluated by the Division's STRUDL program, or by a similar rigorous method of frame analysis.

## l-1.03 Policy and Procedural Changes

Information and instructions in the *California Falsework Manual* are current as of the date of publication. It is expected, however, that changes in policy guidelines and/or procedural direction will from time to time occur. Such changes will be implemented by issuing dated revisions to the manual text. Revisions will be accompanied by instruction or explanation when appropriate.

To expedite implementation, changes may be effected on an interim basis by issuing Falsework Memos, which will then supersede conflicting instructions in the manual text. Falsework Memos are to be filed in Appendix C until manual revisions are issued. To ensure that current policy is readily apparent, interim changes should be noted in the text by an appropriate marginal reference.

## l-l.04 Specification Reference

Whenever the term "Standard Specifications", specifications" or "falsework specifications" appears in this manual, the term is used in reference to the current edition of the Standard Specifications issued by the California Department of Transportation.

## l-l.05 Definitions

Falsework may be defined in general terms as a temporary framework on which a main or permanent work is supported during its construction.

Although temporary supports are occasionally required during the construction of steel structures, the unqualified term "falsework" is universally associated with the construction of cast-in-place concrete structures, particularly bridge structures. In this type of construction, falsework provides a stable platform upon which the forms may be built, and furnishes support for the bridge superstructure until the members being constructed have attained sufficient strength to support themselves. [1]

As commonly used in the construction industry, the term "falsework" refers to the temporary supporting system between the ground and the bridge soffit. Temporary features of construction above the soffit are generally considered to be forms rather than falsework. However, the Standard Specifications provide that the support systems for form panels supporting deck slabs and overhangs on girder bridges will be considered to be falsework members and designed as such. Accordingly, on State highway projects all load carrying members, regardless of their location within the supporting system, must meet the design criteria included in the falsework specifications. [2]

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[1] As a point of interest, note that while falsework is used in conjunction with both bridge and building construction, the temporary supports used in building work are commonly referred to as "shores" and the support system as "shoring".

[2] When considering the purpose of the temporary features of construction above the bridge soffit, it is important to recognize the distinction between "formwork" and "falsework" as these terms are used in the construction industry. Forms, which are used to retain plastic concrete in its desired shape until it has hardened, are designed to resist the fluid pressure of plastic concrete, plus the additional equivalent fluid pressure generated by vibration. Forms, because they do not carry the dead load of the concrete, may be removed as soon as

## 1-1.06 System Types

Typically, bridge falsework may be divided into two general types, briefly described as follows:

(1) Conventional systems in which the various components (beams, posts, caps, bracing, etc,) are each erected individually to form the completed system.

(2) Proprietary shoring systems in which metal components are assembled into modular units that may be stacked, one above the other, to form a series of towers which comprise the vertical load-carrying members of the system.

## l-1.06A Conventional Systems

A typical conventional falsework system will consist of timber posts and caps, timber diagonal bracing, either timber beams or steel stringers, and timber joists. Foundation support is usually provided by timber pads set on the surface of the ground, although poor soil conditions may dictate the use of concrete footings or driven piles to ensure an adequate foundation.

Steel frame bents are sometimes used to carry the heavier loads associated with falsework bents adjacent to traffic openings or other locations where relatively long falsework spans are used. Steel bents are usually supported by concrete footings, or by steel sill beams which distribute the loads to heavy timber pads or cribbing.

Of comparatively recent development is pipe column falsework in which the vertical components consist of Welded steel pipe. Typically, pipe diameters range from 12 to 18 inches, or more, depending on the load to be carried. The pipe columns are framed with steel caps at the top and bottom, and internally braced with small diameter steel rods or reinforcing steel bars. All frame connections are welded.

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the concrete hardens. Falsework members do carry the dead load of the concrete, and therefore they must remain in place until the concrete becomes self-supporting.

Plywood panels on the underside of a concrete slab serve both as a form and as a falsework member. For design, however, such panels are considered to be forms because they must meet the requirements in Section 51-l.O5, Forms, of the Standard Specifications.

1-1.06B Proprietary Shoring Systems

A11 proprietary shoring systems consist of metal components that may be assembled into modular units and erected in place. When erected, the shoring consists of a series of internally braced towers which support the main horizontal load-carrying members and carry the vertical loads to the ground.

Depending on capacity, the various shoring systems marketed commercially may be described as pipe-frame shoring, heavy duty shoring, or intermediate strength shoring. Pipe-frame shoring systems have a rated capacity of 11,000 lbs per leg, or less for some systems, whereas a properly designed and constructed heavy duty shoring system will be capable of carrying up to 100,000 lbs per tower leg. Intermediate strength shoring has a capacity of up to 25,000 lbs per tower leg.

Typically, timber caps and stringers will be used with pipe-frame and intermediate strength systems, and foundation support will be provided by timber pads. The higher capacity of the heavy duty systems will permit longer falsework spans, so that rolled beams or welded plate girders are normally used for the main horizontal load carrying members. In most cases, the larger loads associated with heavy duty shoring will require reinforced concrete footings or pile foundations to ensure adequate support.

1-l.07 Contractual Relationships

In accordance with contract requirements, the contractor is responsible for the design and construction of bridge false-work. Specifically, the Standard Specifications include the following provisions:

From Section 5-1.02, Plans and Working Drawings:

> "Working drawings for...falseworke...shall be submitted when required by the specifications or ordered by the Engineer. Such working drawings shall be subject to approval insofar as the details affect the character of the finished work and for compliance with design requirements..., but details of design will be left to the Contractor who shall be responsible for the successful completion of the work."

From Section 51-1.06, Falsework:

> "The Contractor shall be responsible for designing and constructing safe and adequate falsework which provides the necessary rigidity, supports the loads imposed, and produces in the finished structure the lines and grades shown on the plans,"

Since the contractor is responsible for falsework design and construction, he determines the type of falsework to be used and the construction and removal methods to be employed, subject only to compliance with the design criteria and the conditions of use found in the specifications. It is the engineer's responsibility, however, to ensure by his review that the falsework design meets all contract requirements.

From the foregoing, it is evident that the basic relationship between the contractor and the engineer with respect to falsework is the same as the relationship in other aspects of contract work, with one significant difference. The engineer, when satisfied that all contract requirements have been met, must approve the contractor% design and construction details as shown on working drawings that have been prepared and submitted specifically for review and approval by the engineer pursuant to applicable contract provisions.

Under Department of Transportation policy, review and approval of the contractor's falsework design is a Division of Structures responsibility. This responsibility is delegated to the Office of Structure Construction's structure representative at the project site. It is the structure representative, therefore, who must determine whether the proposed falsework design, as shown on the falsework drawings, meets contract requirements.

When reviewing falsework drawings, keep in mind that approval of the drawings constitutes acceptance by the State of the falsework design and such construction details as may be shown on the drawings, and an acknowledgment that the design does in fact meet contract requirements.

Responsibility for review and approval of falsework drawings is not a matter to be taken lightly. Falsework drawings shall not be approved until, and unless, the structure representative is satisfied that the proposed falsework design complies in all respects with all applicable contract requirements.

## 1-1.08 Cal-OSHA Falsework Requirements

The *Construction Safety Orders* issued by the California Department of Occupational Safety and Health (Cal-OSHA) include various provisions which apply to the design and construction of falsework or vertical shoring, including falsework or shoring for structures being constructed on State highway projects.

Applicable *Construction Safety Orders,* and the engineer's responsibility with respect to those orders as they affect approval of falsework drawings and falsework inspection, is discussed in Chapters 2 and 9, respectively.